Economic Development, Jobs, Transport and Resources

Technical Guideline

Design and Management of Tailings Storage Facilities

April 2017

EARTH RESOURCES REGULATION

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1 Introduction

This guideline aims to provide proponents and licensees with relevant information and requirements for preparing a mining work plan under Section 40 or extractive industry work plan under Section 77G of the *Mineral Resources (Sustainable Development) Act 1990* (MRSDA) for assessment and approval by the Department of Economic Development, Jobs, Transport and Resources (the department). The guideline is also intended to assist licensees in their annual statutory reporting obligations by providing additional detail as to what information is required.

This guideline has been developed by the **Earth Resources Regulation (ERR)** branch of the department. It aims to ensure that the management of **Tailings Storage Facilities (TSF)** and associated **tailings** from mining and extractive industries in Victoria is undertaken in a manner that is safe and protects the environment. It also aims to promote the adoption of the best industry standards and practice, and continual improvement in tailings management.

This guideline seeks to ensure that a TSF throughout its operational life and after closure is:

- designed, constructed, operated, monitored and closed in accordance with the Australian National Committee on Large Dams' *Guidelines on Tailings Dams – Planning, Design, Construction, Operation and Closure* (ANCOLD 2012a), other ANCOLD guidelines and *State Environment Protection Policies* (SEPPs) where relevant
- safe and structurally stable
- managed to minimise impact on public safety, public infrastructure and the environment
- rehabilitated to minimise social impact, adverse visual amenity and long-term risks to the environment.

Tailings storage operations have four main stages – design, construction, operation and decommissioning. These stages are generally not discrete, as decisions and actions at each stage impact on the subsequent ones. It is essential that from the commencement of the approval process, the design and planned operations consider the eventual closure and decommissioning of the TSF. Any variations to TSF management throughout the life of the mine should also take into account implications for the closure and decommissioning of the site. This guideline accepts flexibility in approaches to allow innovation in tailings management and to accommodate variations between sites in the physical, technical and social environments.

1.1 Application of this guideline

This guideline applies to large tailings storage facilities, as defined below.

Large TSFs are those with one of the following:

- An embankment of 5 metres or higher[1] and a storage capacity of 50 megalitres (50,000 cubic metres) or more
- An embankment of 10 metres or higher and a storage capacity of 20 megalitres (20,000 cubic metres) or more
- An embankment of 15 metres or higher, regardless of storage capacity
- The combined storage capacity of all TSFs on the site is 50 megalitres (50,000 cubic metres) or more[2]
- The tailings contain, or are predicted to contain, concentrations of contaminants exceeding those levels outlined in Section 6.4 regardless of capacity or size.

A separate departmental guideline applies to **small tailings storage facilities**. Small TSFs are those which are not classified as a large TSF according to the above criteria. Small TSFs can be managed to meet the requirements of the department's guideline *Management of Small Tailings Storage Facilities 2006* (or subsequent revision).

The majority of large TSFs are within the mining sector and accordingly that is the focus of this document.

In the event that a TSF is considered a small TSF, but has a consequence rating (see Section 6) of 'high' or above in accordance with ANCOLD (2012a), this guideline (*Design and Management of Tailings Storage Facilities 2016)* is considered the appropriate guideline for management of the TSF.

[1] The height of the embankment should be determined from its maximum height above natural surface downstream of the dam.

[2] The combined storage criteria is to capture multiple small dams that would otherwise not fall under this guideline but collectively, should multiple failures occur, lead to a higher cumulative risk.

1.2 Tailings disposal methods not covered by this guideline

This guideline does not cover the disposal of tailings in to open pit or underground mine voids. It is noted, however, that Section 20 (1) of the *State Environment Protection Policies (SEPP) Groundwaters of Victoria* states that this practice may occur provided that the Environmental Protection Authority (EPA) is satisfied that the groundwater quality objectives are met and that there is no detriment to beneficial uses of groundwater, land or surface waters. Any proposal to undertake this practice should be discussed directly with the department and the EPA.

Disposal techniques involving the submarine placement of tailings, or any uncontrolled placement of tailings in natural waterways, are not permitted in Victorian waters. Accordingly, this guideline does not address such activities.

1.3 Amendments to legislation and other documentation

It is recognised that from time to time, legislative instruments and documentation referred to in this guideline will be amended or updated. Where these are reviewed or updated, the most recent version is applicable.

This guideline will be reviewed as necessary to maintain consistency with legislative instruments or other relevant documents.

1.3.1 Definitions

Definitions are included in Appendix VI. Terms covered are shown in **bold font** throughout the guideline.

PART A: GENERAL CONSIDERATIONS

2 Definition of tailings material

Tailings from the mining and extractive industries are most commonly fine-grained or finely ground materials left over from the extraction, beneficiation or concentration processes. Most of these processes are water based, and consequently tailings are usually produced, transported and discharged into a TSF as slurry.

Tailings are typically chemically similar to the parent material, but have been subjected in some way to physical and/or chemical separation processes, such as crushing and grinding, flotation, cyanidation or acid leaching, which can have significant influences on their properties and behaviour. In addition, the presence of process reagents, evaporation of water, weathering and access to oxygen after deposition may alter its physico-chemical properties and risk profile.

A TSF may therefore contain constituents that require careful management. Typical adverse characteristics of tailings can include:

- remnant cyanide
- radioactivity
- alkalinity (high pH) or acidity (low pH)
- sulphides, which may generate acid and consequently mobilise heavy metals
- elevated arsenic levels
- highly saline pore water
- release of toxic gases
- colloidal clays (which are not adverse chemically, but have a deleterious effect on settling and strength characteristics). Similarly, tailings that segregate after deposition may result in slime ponds that have particularly adverse physical characteristics for long term stability.

Further information on the characterisation and behaviour of tailings can be found in ANCOLD (2012a) Section 4, and *Tailings Management – Leading Practice Program for the Mining Industry* (Australian Government, 2016).

3 Definition of a tailings storage facility

TSFs are built structures used to confine tailings. A TSF includes the dam or other structure and associated tailings delivery infrastructure. The term refers to the overall facility, and may include one or more tailings dams.

The primary purpose of a TSF is to safely contain tailings to achieve solid sedimentation and consolidation, and to facilitate water recovery or removal without impacting on the environment. The nature of TSF design and operation is fundamentally different from a water dam in the way water is managed and in rehabilitation and closure. A TSF should not be used for the storage of water. Where a TSF is to permanently hold water (such as where sub-aqueous tailings disposal is proposed), the design of the TSF should also be consistent with standards used for water reservoirs.

4 Risk-based Work Plan

The *Mineral Resources (Sustainable Development) (Mineral Industries) Regulations 2013* (MRSDMIR) and the *Mineral Resources (Sustainable Development) (Extractive Industries) Regulations 2010* (MRSDAEIR) require a risk-based work plan or work plan variation to be lodged and approved before any work, including the construction or operation of a TSF, can commence under the licence. Proponents must ensure that the work plan for a TSF contains the details required by either the MRSDA or the appropriate regulations.

Licenses are required by the MRSDA to ensure they eliminate or minimise their risks as far as reasonably practicable. The actions that a license or work authority holder undertakes to achieve this outcome must be detailed in a risk-based work plan under Section 39 (ab) of the MRSDA. Proponents should ensure that a work plan submitted for approval complies with these guidelines.

Where a TSF is part of a larger mining or quarrying proposal, the work plan requirements described in this guideline may be addressed as part of the work plan for the overall project. Where a TSF is proposed as supplementary work on an existing site or a significant change to an existing TSF is proposed (and these are outside the provisions of the current work plan), the operator must submit a work plan variation.

A key purpose of the work plan is to set out the planned operational phase of the TSF to reduce risk to the environment, the public and surrounding infrastructure. This should include planning for the systematic deposition of tailings, water and process chemicals in the facility.

For a site with a proposed TSF, the work plan documentation would typically include but is not limited to:

- site description including expected climatic conditions
- suitably scaled and referenced maps and plans, including a location map and a general arrangement in Australian Map Grid (AMG) coordinates
- a site investigation report detailing surface water and drainage, site geology, hydrogeology and expected TSF foundation conditions as well as long-term embankment stability, if applicable
- a design report including plans showing physical dimensions and details of capacity (see Section 8)
- surface water diversion and drainage to minimise flows into the TSF
- the expected composition of the tailings and decant water (chemical, physical, rheological, geotechnical and mineralogical) (Section 6.4)
- clear statement of the quantity of tailings to be stored and a quantitative water balance that accommodates all gains and losses
- risk assessment to evaluate potential impacts relating to the environment and public safety, and hydrogeological, geotechnical, and embankment-related hazards posed by the design, operation rehabilitation and closure of the TSF (Section 4.1)
- details about the proposed construction and operation of the TSF and associated infrastructure, including the proposed management of the tailings and water
- an environmental management plan outlining how potential TSF-related impacts on the surrounding environment will be minimised (Section 4.2)
- a community engagement plan that addresses the addition of a TSF (Section 4.3)
- a program for monitoring, auditing and reporting of safety, operational and environmental factors appropriate to the nature and scale of the operation and the criteria that will be used to assess performance (Section 12)
- an emergency response plan including a failure scenario analysis of dam break and land inundation (Section 13)
- plans for closure and rehabilitation including a description of the intended end use of the site (Section 14).

Additional information to demonstrate compliance with these items should be supplied as required.

Section 2 of ANCOLD (2012a) provides a discussion of the overall management requirements for a TSF over the whole of life of the facility.

4.1 Risk management

The proponents of a TSF should adhere to the principles of risk management (eg. Standards Australia AS/NZS ISO 31000:2009) and ensure that potential risks to the community, workforce and environment are minimised.

Proponents are required to undertake and document a formal risk assessment to inform the siting, design and proposed operational and monitoring procedures, and include the results as part of the work plan submission. The work plan must also address items 2, 3 and 4 of Schedule 15 of the MRSDMIR or of Schedule 1 of the MRSDEIR, with regards to risk. The type and methodology chosen for the risk assessment will depend on the complexity and magnitude of the risk, the criticality of the elements under consideration, the potential consequence of failure and the quality of data available. In accordance with ANCOLD (2012a, Section 2.2), quantitative risk assessments should be undertaken for TSFs having a high or extreme **consequence category** (Section 6).

When conducting a risk assessment related to land and groundwater contamination, reference should be made to *SEPP Prevention and Management of Contaminated Land, SEPP Groundwaters of Victoria* and the conceptual site model approach outlines in *National Environmental Protection (Assessment of Site Contamination) Measure* (2013 amendment) (NEPM (ASC)). Similarly for surface water, the risk approach in *SEPP Waters of Victoria* should be considered. These guidance documents are also relevant for the management of cyanide.

Further information on risk assessment is available in Guidelines on Risk Assessment (ANCOLD 2003b).

Risk assessment for the management of cyanide

The proponent should provide a detailed and operation-specific risk assessment for the management of cyanide tailings on site. The TSF design and management approach should demonstrate that the proposed measures will minimise risks in accordance with best practice.

Factors to be considered in relation to management of cyanide include:

- planned and possible discharge concentration and amounts from the plant to the TSF
- potential impact on wildlife
- risk to surface waters
- risk to groundwater
- risk to livestock and domestic animals
- risk to the public and to public infrastructure.

Controls that could be considered to mitigate the risks of tailings containing cyanide include:

- education and training
- reduction or elimination of the amount and concentration of cyanide in tailings
- animal deterrents (acoustic or visible)
- physical barriers to prevent access by animals to the water, such as fencing, mesh covers or floating barriers
- decant systems or seepage control to reduce the surface area of the pond;
- more intensive site supervision
- amendments to design criteria such as deposition method
- periodic review and updating of site procedures and safety systems.

The gold mining industry has adopted a voluntary code *International Cyanide Management Code* (ICMI 2012), which sets out a suitable approach for the management of cyanide. This provides additional guidance to assist proponents in implementing best-practice measures for their sites. Supporting guidance can be found in the Leading Practice Sustainable Development Program manuals for the mining industry and the Australian Government's *Cyanide Management – Leading Practice Sustainable Development Program for the Mining Industry*, (May 2008).

4.2 Community engagement

Under the MRSDA, all licence holders have a duty to consult with the community.

The duty to consult applies throughout the period of the licence including initial development, during operation, when major changes occur (such as the addition of a TSF) and at site closure. Consultation should commence at the planning stage of a project.

For new work plans or variations to an existing work plan for a TSF, a proponent will be required to submit a community engagement plan along with the work plan or variation. The requirements for a community engagement plan are set out in MRSDMIR and the MRSDEIR.

Further information on community engagement is provided in *Community Engagement Guidelines for Mining and Mineral Exploration in Victoria,* available at http://earthresources.vic.gov.au/earth-resources-regulation/licensing-and-approvals/minerals/guidelines-and-codes-of-practice/community-engagement-guidelines-for-mining-and-mineral-exploration.

5 Approvals under other Acts

In addition to the departmental work plan requirements, the proponent for a TSF may also need to apply for additional approvals as described below. Further information on the provisions of these Acts and others is summarised in Appendix IV.

5.1 *Water Act 1989*

Under the *Water Act 1989,* a dam is defined as "anything in which by means of excavation, a bank, a barrier or other works, water is collected, stored or concentrated". A tailings storage facility that includes a tailings dam which collects or stores water or disrupts surface water flows, is likely to meet the definition of a 'dam' as described under this Act.

Under Section 67(1A) of the *Water Act* a licence is required to construct a **private dam** that is not on a waterway that:

(a) has a wall that is 5 metres or more high above ground level at the downstream end of the dam and a capacity of 50 megalitres or more; or
(b) has a wall that is 10 metres or more high above ground level at the downstream end of the dam and a capacity of 20 megalitres or more; or
(c) has a wall that is 15 metres or more high above ground level at the downstream end of the dam, regardless of the capacity; or
(d) is a dam belonging to a prescribed class of dams.

The size and capacity specified under Section 67(1A) (a) (b) and (c) is also used to classify a TSF as a 'large TSF' based on size and/or capacity (along with other criteria) in Section 1.1 of these guidelines.

A TSF proposed to be constructed on a waterway also requires a licence under the Water Act regardless of size.

As the licensing authority, the Rural Water Corporation (RWC) considers relevant matters under Section 40 of the *Water* Act during its assessment and will review aspects including the potential impacts to surface water flows, groundwater and to downstream uses.

Section 75 (1A) of the *Water Act* allows for the construction of a private dam to be recognised under another Act. This may include the work plan approval provisions of the MRSDA, depending on the specific site characteristics and RWC requirements.

Where a proposed TSF falls within the criteria specified in the Water Act, it is essential that the proponent engages the RWC at an early planning stage of the project. This will allow the RWC to advise the proponent on whether authorisation could potentially be provided through the department's existing work plan referral and approval process and advise on the specific information that would be required, or whether a separate licence application directly to the RWC is required. Discussion should be initiated between the proponent, the RWC, the department and Department of Environment, Land, Water and Planning (DELWP) (where relevant) to confirm the authorisation method on a case-by-case basis.

5.2 *Planning and Environment Act 1987*

The proponent for a TSF may need to apply to the **Responsible Authority** (usually the local municipality) for planning approval under the *Planning and Environment Act 1987*. The proponent should confirm with the Responsible Authority whether planning approval is required.

5.3 *Environment Protection Act 1970*

The discharge of mining wastes (tailings) to land within an approved mine or quarry site which is undertaken in accordance with the MRSDA is exempt from works approval and licensing under the *Environment Protection (Schedule Premises and Exemptions) Regulation 2007.* This situation applies where waste is discharged to a TSF, an evaporation pond or to another system.

If a proposal includes an offsite discharge to the environment, a works approval and licence is required under Section 19A and Section 20 of the *Environment Protection Act 1970.* Confirmation and further information should be sought from the EPA where a proposal may require licencing and works approval.

5.4 *Environmental Effects Act 1978*

Where a proposed TSF has the potential for significant environmental impacts, assessment via an Environment Effects Statement (EES) in accordance with the *Environment Effects Act 1978* may be required.

For mining projects, approval via an EES precludes the need to seek approval by way of a planning permit.

5.5 Aboriginal Heritage Act 2006

Under the *Aboriginal Heritage Act 2006,* a Cultural Heritage Management Plan may be required when proposing to carry out listed high-impact activities (listed under the *Aboriginal Heritage Regulations 2007*) in an area of cultural heritage sensitivity.

The construction or alteration of a private dam is a listed high-impact activity under the regulations if a licence is required under Section 67(1A) of the *Water Act 1989* for the construction or alteration of that dam. As such proponents need to determine whether a cultural heritage plan or other approval under the *Aboriginal Heritage Act 2006* is required for their project. Further information is provided on the Office of Aboriginal Affairs Victoria website www.dpc.vic.gov.au.

5.6 Other Legislation

Proponents should consider all other relevant and applicable legislation:

- Approval under the Commonwealth *Environment Protection and Biodiversity Conservation Act (1999).*
- Requirements under the *Permitted Clearing of Native Vegetation – Biodiversity Assessment Guidelines* (DELWP 2013), particularly with regards to the need for offsets where vegetation is removed.

Further information on legislation that should be considered by proponents is provided in Appendix V.

PART B: DESIGN

6 Consequence assessment

6.1 General

The **consequence category** for a TSF is assessed and reported as part of the design and submitted as part of the work plan or work plan variation.

As outlined in the ANCOLD (2012a Section 2.3 including Table 1 and Table 2) there are two consequence categories assessed for design purposes:

1. The dam failure consequence category.
2. The environmental spill consequence category.

The results of these assessments are included in the TSF failure or spill consequence assessment as this will help to determine the risk to the environment, public safety and infrastructure associated with a spill or discharge of tailings and therefore the standard of design, construction and operation required.

A conceptual site model (Section 4.1) should also form part of this assessment to help determine the risk.

6.2 The dam failure consequence category

The dam failure consequence category is the evaluation of potential failure modes of the TSF and the consequences to public safety, the environment and public infrastructure as a result of the failure (*Guidelines on Consequence Categories ANCOLD, 2012b).* A quantitative risk assessment should be undertaken for TSFs having a high or extreme consequence category.

6.3 The environmental spill consequence category

As outlined in ANCOLD (2012a) the environmental spill consequence category is determined by considering only the effects of a spill from the TSF during a flood or extended extreme wet weather period. The impact of an event under these circumstances is normally limited to environmental impacts and consequently, the environmental spill consequence category may be lower than the dam failure consequence category.

6.4 Composition of tailings and decant water

In assessing the consequence category, consideration is given to the concentration and type of contaminants present or expected to be present in the tailings and decant water as well as physical characteristics such as turbidity. The consequence assessment includes the potential health and environmental impacts associated with that level of contamination in the event of a dam failure or spill.

For initial consideration, tailings that have the potential for higher impact are defined in this guideline as:

- tailings solids with contaminant concentrations (or predicted concentrations) above any of the levels specified in Table 1, and/or sulphidic tailings with the potential to cause acid and metalliferous or saline drainage and/or
- decant water with (or predicted to have) a total cyanide concentration exceeding 1 milligram per litre, and/or a pH outside the range 5 to 9.

Methods for determining acid generation potential are provided in *Managing Acid and Metalliferous Drainage* (Australian Government 2007b) and *EPA Publication 655.1 Acid Sulfate Soil and Rock* (EPA 2016).

Table 1: Tailings with contaminant concentrations above these levels are considered to have the potential for higher impact [1]

Contaminant	Maximum Concentration (total) mg/kg dry weight	Leachable concentration mg/L [2]
Arsenic	500	0.7
Cadmium	100	0.2
Chromium (VI)	500	5.0
Copper	5,000	200
Cobalt	500	-
Lead	1,500	1.0
Mercury	75	0.1
Molybdenum	1,000	5
Nickel	3,000	2
Tin	500	-
Selenium	50	1.0
Silver	180	10
Zinc	35,000	300
Cyanide	2,500	8
Fluoride	10,000	150

[1]The concentrations shown in Table 1 have been adapted from Table 2 of EPA Publication *IWRG621 Soil Hazard Categorisation and Management* for the purposes of this guideline.

[2]Leachabilty testing is undertaken in accordance with the Australian Standard Leaching Procedure (ASLP).

The consequence assessment also considers relevant physical characteristics (such as turbidity) and additional chemical constituents (not mentioned in Table 1) associated with the tailings and decant water, and the potential impact these may have on the surrounding environment in the event of seepage or a spill. Turbid water in particular can cause a significant impact to the surrounding environment immediately following a spill event.

In addition, consideration should be given to how the tailings interact with the clay or other materials used to build the TSF and whether it can impact the integrity of the TSF.

In considering potential environmental impacts of tailings and decant water, relevant water quality documents such as the *SEPP (Waters of Victoria, Groundwaters of Victoria)* and the *Australia and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC 2000)* should be used.

Where tailings or decant water have a higher potential impact as per this section or have attributes that lead to a higher consequence in the event of a spill, the TSF will require higher standards of TSF design and operation, consistent with an consequence category of 'high' or 'extreme'.

7 Site selection

The site for a TSF should be selected to minimise the potential impact of the facility on people, public infrastructure and the environment. A key aspect of reducing the risk associated with TSF failure is to ensure it is located and designed to have the smallest practicable catchment and to hold the minimum amount of water possible.

The proponent for a TSF should identify and investigate reasonable potential alternative sites and undertake a realistic assessment of comparative risks.

Factors that should be considered as a minimum include:

- topography
- site geology, foundation conditions
- natural chemical composition of the site (understanding of naturally occurring metals for example)
- hydrogeology (depth to groundwater, groundwater quality and beneficial use)
- hydrology (natural surface water flow and management requirements, the area and nature of the catchment above the TSF, possible catchment diversions)
- availability of construction materials
- climatic conditions (rainfall patterns, evaporation, prevailing winds)
- seismic risk data relevant to the area
- location of current (and future/planned) public safety, public infrastructure and environmental elements which may be impacted by a flood/seepage event from the TSF
- the distance from sensitive receptors including waterways, other environmental or cultural features, neighbouring property owners, land and water users (proponents should plan to maximise the distance of the TSF from these features)
- proximity to the mineral licence boundary
- adjacent mine infrastructure (including pits and underground workings)
- proposed construction methods and staging
- tailings deposition and management approach
- water management
- effects of works on downstream flow regimes, including both flooding and dry weather flows
- current and final land use
- potential for additional mineral resources under the proposed site
- planned rehabilitation outcomes including provision of long-term safe and stable closure.

Siting a TSF on a natural drainage line or waterway increases the potential risk associated with storing higher volumes of water and the department does not consider this to be a suitable location for a TSF. If a cross-valley dam is the only practicable alternative, the proponent needs to demonstrate that all environmental risks including the effect on downstream users and the water resource itself have been identified and are adequately addressed in the proposed design, construction and operation of the TSF, and be able to demonstrate compliance with relevant SEPPs.

The proposed locations should be supported by a conceptual geotechnical and hydrogeological model as the basis for comparative risk assessment to support the final choice of TSF location. Development of the conceptual models may require site investigation to determine the geotechnical and hydrogeological characteristics of the proposed sites.

EPA Publication 668 Hydrogeological Assessment (Groundwater Quality) Guidelines 2006 provide further assistance on what should be included in a hydrogeological assessment and *The National Environment Protection (Assessment of Site Contamination) Measure 1999* (NEPM ASC) should be consulted around a conceptual site model.

Methods of tailings storage and disposal principles, together with issues related to protection of community, environment and infrastructure are discussed further in ANCOLD (2012a), Section 3.

8 Development of a TSF design

8.1 Design overview

The primary objectives for the design of a TSF are detailed in ANCOLD (2012a) and include:

- the safe and stable containment of tailings
- the safe management of decant and rainfall runoff
- the management of seepage
- the ability to achieve long term effective closure, leaving no unacceptable environmental legacy
- the meeting of the objectives in a cost-effective manner.

A TSF design should be tailored to the particular site conditions, the mineralogy and treatment of the raw material, the construction process to be adopted, and the desired long-term landform. In particular, the TSF design is informed by and enables the rehabilitation strategy and post-closure arrangements for the site and the mine in general.

It is essential that the design is prepared by a suitably qualified 'designer'. ANCOLD 2012(a) defines a designer as being "a person with appropriate qualifications and experience responsible for the design of the tailings dam". The designer should also meet the requirements of a '**Dams Engineer**' as defined in ANCOLD (2012a).

The design should fulfil the following:

- be suitable for the proposed use
- meet contemporary standards as outlined below
- have identified and addressed all the likely risks associated with:
    - the site
    - the nature of the materials used in the containment structure(s)
    - the nature, quantity and treatment of the tailings
    - the construction process
    - operation of the TSF
    - rehabilitation and closure.

The design of a TSF should be based on appropriate standards and principles (but not necessarily be limited to these) such as those outlined in:

- *Guidelines on the Consequence Categories for Dams* (ANCOLD 2012b)
- *Guidelines on Tailings Dam Design, Construction and Operation* (ANCOLD 2012a)

8.2 Design report

The design report describes the basis of the design, including the design concept/philosophy and all design parameters such as geotechnical properties of the tailings and construction materials, the meteorological conditions and the key performance criteria. The design report is critically important in determining the safety controls, operating procedures and maintenance programs that need to be implemented for the successful operation of the facility (ANCOLD, 2012a).

In addition the report should:

- assess the design against identified risks and outline how this assessment was used to develop the design
- outline the required construction supervision and control
- outline the monitoring and surveillance criteria to be used in operation
- outline the proposed closure methodology.

A typical table of contents for a design report is included in Appendix A of ANCOLD (2012a).

- The following documentation should be provided to the department as part of the work plan submission:
    - design report prepared in accordance with ANCOLD (2012a) and this guideline
    - design certification– confirmation from a suitably qualified 'Designer' that the design meets appropriate engineering and safety standards and is consistent with this guideline
    - Tailings Storage Facility Data Sheet (Appendix II).

8.3 Types of tailings storage facility

Proponents should demonstrate that the most appropriate deposition and containment method has been selected. Contemporary types of TSF and their construction are described in Section 3 of ANCOLD (2012a).

TSFs using wet deposition (sub-aqueous deposition, or methods that will result in a decant pond forming against an embankment) should be avoided. If there is no alternative to this type of TSF then the proponent should demonstrate the following:

- There are no reasonably practicable alternatives to wet deposition.
- This method of design and construction can adequately address risks to public safety, public infrastructure and the environment.
- The volume of water accumulated in the TSF can be maintained at safe levels.
- That rehabilitation can be achieved in accordance with the approved rehabilitation plan.

Construction of a dam style TSF with a decant pond forming against an embankment will require specific design related to stability of the embankment and potential risks such as seepage through the embankment. Conventional TSF design usually involves an initial embankment with subsequent lifting of the dam crest as the need arises. For a dam-style TSF the initial embankment should form a substantial part of the final structure with lifts kept to a minimum. Proponents should specify the type and number of lifts proposed for the final configuration of the TSF in the initial design report. The department may limit approval to a lesser number of lifts, and require the proponent to demonstrate compliance with the initial design, or submit modifications to the initial design, as part of approval for any subsequent raise.

An important factor in the selection of embankment type and method of deposition is the degree of seepage control achievable. This may have a critical influence on the stability of the embankment.

8.4 Design – embankment

The objective of the tailings storage embankment design is to ensure that the structures are able to withstand the potential loading condition that would be expected during their lifetime (both operational and post-closure) to the extent that the risk of failure is as low as reasonably possible.

The design criteria for a tailings dam embankment is set out in section 6 of ANCOLD (2012a). This provides guidance on the following design subjects:

- Stability:
    - Material shear strength (drained long term and undrained short term) seepage control and embankment drainage.
    - Stability of an embankment where loading and/or failure occurs rapidly enough that there is no time for drainage.
    - Earthquake (including post-seismic stability).
    - Deformation during earthquake (including liquefaction potential).
    - Long-term post-closure stability.
- Settlement:
- Construction materials for initial embankment construction and subsequent lifts:
    - Stability of saturated construction materials.
    - Stability of renewed deposition over old impoundment .
    - Permeability.
    - Piping.
    - Dispersion.

The use of exposed tailings to construct the dam embankment is not considered acceptable.

8.5 Design – water management

8.5.1 Tailings water recovery system

Good water management including the design of a decant and water recovery system is critical to the safety of a TSF and the quality of the final outcome.

The design should include the documentation of a quantitative water balance of the whole system which contributes to the TSF water balance. For any TSF having a consequence category of ‘significant’ or higher, a stochastic water balance should be undertaken daily.

A water balance should consider the following:

- All storages in the system including TSF, evaporation ponds, process water ponds and any other storages.
- Gains and losses including process water, rainfall, catchment run-off, storm events, seepage and evaporation.
- Water retained in the deposited tailings.

Run-off calculations should be made in accordance with normal hydrological methods, as outlined in *Australian Rainfall and Runoff* (Institute of Engineers, 1999).

The water balance should demonstrate that the design accommodates the ‘worst case’ combination of factors identified in the risk assessment over the full range of climatic conditions expected throughout the life of the TSF.

Documentation of the water balance is included in the design report. The results of the water balance should be used to set the maximum design operating level of the storage (refer Table 2).

8.5.2 Water management

Water storage

Tailings dams are required to provide adequate tailings disposal and water holding capacity to provide for dam safety, as well as environment and infrastructure protection.

Section 5 of ANCOLD (2012a) sets out the procedure for the design of the tailings dam with regard to tailings capacity, decant water volume and storm water retention.

Water design requirements for TSFs including freeboard and emergency spillways are specified in Tables 2 and 3 below. These are adapted from criteria outlined by ANCOLD (2012a). The various freeboard and storage provisions are illustrated in Figure 1.

Spillway

Appropriately designed emergency spillways are required for all TSFs to deal with the exceptional circumstance where there is a risk of embankment failure due to flood overtopping. The spillway should be designed to discharge the peak out-flow from the storm event as specified in Table 2 without significant damage to the embankment and infrastructure. The design freeboard for various Consequence Category TSFs in storm events is specified in Table 3.

Table 2: Tailings storage facilities emergency spillway criteria (ANCOLD 2012a)

Dam Spill Consequence Category	Minimum Emergency Spillway Capacity Annual Exceedance Probability (AEP) of Critical Rainfall event, (TSF full to spillway level at the beginning of the storm)	Recommended Freeboard (m) (Wave Height + Run up) or (AEP of Design Wind)
Very Low/Low	1:100	Nil
Significant	1:1,000	0.3m
Low/ Significant	1:1,000	1:10
High C	1:100,000	1:10
	Probable Maximum Flood (PMF)	0
High B	1:100,000	1:10
	PMF	0
High A/Extreme	PMF	0

Designers should be aware that these are minimum requirements, and should consider the costs and potential benefits in terms of reducing the overall risk by adopting more stringent criteria.

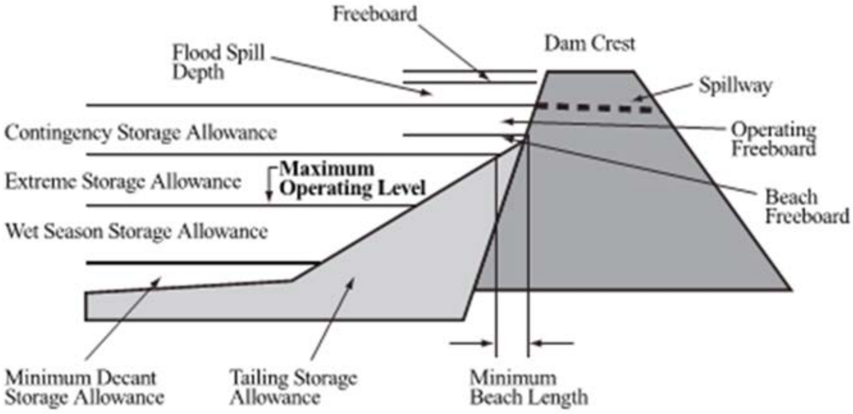
Table 3: Tailings storage facilities environmental spill design freeboard (ANCOLD 2012a)

ANCOLD Environmental Spill Consequence Category	Design Maximum Operating Level (AEP of Design Wet Year)	Storm Storage Capacity (AEP of 72 hour rainfall event)	Contingency Storage Allowance	
			Wave Freeboard Allowance (m) (Wave Height + Run up) (AEP of Design Wind)	Additional Freeboard (m)
Low	1:5	1:10	Nil	Nil
Low	1:10	1:100	Nil	Nil
Low	1:5	1:10 / 1:100	Nil	Nil
Significant	1:10	1:100	1:10	0.3
High C	1:100	1:100	1:10	0.5
High B, A & Extreme	1:100 to 1:1000	1:1000/ 1:10,000	1:50	0.5

Note: TSF spillway level is to be set to provide water storage capacity for Design Maximum Operating Level + Storm Storage capacity + Contingency allowance (see Figure 1).

Where diversion of clean runoff water around a TSF is required, works should be carefully designed to prevent downstream physical impacts such as erosion, siltation or impacts to water quality as described in *SEPP Waters of Victoria (1988)*. Design of diversion works should be based on site-specific hydrological data, and should be in accordance with the climatic assumptions included in the water balance.

Figure 1: Freeboard definitions (ANCOLD 2012a)



8.6 Pipelines

Considerations for the design, operation and management of pipelines are as follows:

- containment of accidental discharge as a result of the failure of mechanical systems
- appropriate maintenance and replacement schedules for mechanical equipment in accordance with manufacturers' guidelines, and as necessary for safe and secure operation
- provision of instrumentation and control systems designed to shut down the tailings delivery pipeline and decant water return systems if loss of flow condition is detected.

The proponent should be able to demonstrate that the measures proposed are suitable to manage and mitigate potential risks.

8.7 Seepage containment

TSFs are designed to ensure that the beneficial uses of groundwater and surface water are protected and to prevent other undesirable impacts such as waterlogging and land salinisation.

Seepage assessment is necessary as part of detailed design to:

- determine potential impacts of seepage on the receiving environment
- allow for the design of drainage and collection systems.

Seepage may be controlled by the installation of a liner over all or part of the base of the TSF, and/or adequate under-drains. In some cases, an external seepage collection system may be required.

Proposed seepage control measures should be subject to appropriate risk assessment as outlined in Section 4.1.

TSFs without liner

Where tailings are inert, there is no risk of contaminants leaching to groundwater and the underlying substrate provides a low permeability foundation, a liner may not be required. Where it is proposed that a liner is not required, the proponent needs to undertake an assessment demonstrating that the ground conditions and the proposed design are suitable for the control of seepage to protect beneficial uses of surface water and groundwater, and prevent impact to surrounding land in the absence of a liner. EPA guidance documents for permeability of foundations for Landfills (*Publication 788.3, Siting, design, operation and rehabilitation of landfills*) and guidance for compost pads (*Publication 1588, Designing, constructing and operating composting facilities*) provide further guidance that may be of assistance.

TSFs with liner

Where a seepage assessment determines that a liner is required and/or the tailings have a higher potential impact, the risk assessment process should be used to evaluate and select the following:

- An appropriate design permeability.
- Liner type:
  - Low permeability naturally occurring substrate.
  - Clay.
  - Artificial (geomembrane or geocomposite).
- Liner longevity.
- Lliner susceptibility to damage.
- Liner thickness.
- Liner compatibility with the retained tailings.
- Interaction of tailings with the liner (chemistry).

The design should specify a minimum thickness for the liner, taking the following factors into account:

- The minimum liner thickness compatible with proposed construction methods.
- Protection of the liner during and after construction.

Where the assessment concludes that containment using a constructed liner is required, the standard of containment used should at least be equivalent to a constructed liner of 1.0 metre thickness of clay, with a hydraulic conductivity of 1×10^{-9} m/sec.

EPA Publication 788.3 Siting, Design, Operation and Rehabilitation of Landfills (2015) provides additional information that may assist with achieving this level of containment.

8.8 Design for closure

Provision for closure is an important part of design. The design should include considerations of how the TSF is to be rehabilitated and closed, including final land use and configuration, water management, capping and slope modification, the source of the materials required and any long-term maintenance program for the upkeep of the structure. Further details regarding closure and rehabilitation are included in Section 14.

PART C: CONSTRUCTION

9 Construction overview

It is essential that construction of a TSF accords with the approved design and is carried out to a high standard of workmanship. Adequate supervision of the works is essential to ensure relevant factors are addressed.

The responsible engineer has responsibility for the technical direction of the work, supervision during construction and for certification of the construction works.

ANCOLD (2012a) defines a responsible engineer as "person with appropriate qualifications and experience responsible for the supervision of construction of the tailings dam. Ideally this should be the designer, or if not, a well-defined linkage between the design and supervision personnel should be developed to ensure that design requirements are met by the construction and operational phases".

Where it is necessary to modify the design of the TSF during construction, the proponent should discuss this with the department. It is essential that a revised design, design drawings and certification of the modification from the person who certified the original design is obtained. A work plan variation is likely to be required to enable the department to approve the change.

Upon completion of the initial construction, and upon the completion of each lift or construction stage, the proponent should:

(a) obtain certification from the Responsible Engineer that the TSF has been constructed in accordance with the certified and approved design plans
(b) submit the 'as constructed' report and the construction certification to the department.

The retention of construction records is essential for the effective monitoring of long-term performance. 'As constructed' records detailing the construction of each stage should be prepared and retained to assist determination of the overall stability and the future life of the TSF.

The records should include survey drawings of:

- the final ground surface contours inside and outside the TSF
- original ground surface contours inside and outside the TSF
- location of test boreholes and pits (and details regarding their backfilling)
- finished embankment locations, levels and sections
- the locations of the drainage system
- location and details of instrumentation installed
- confirmation that the liner has been constructed to the required specifications.

A typical table of contents for a dam construction report is included in ANCOLD (2012a), Appendix C.

Additional details and requirements for the construction of a TSF are outlined in Section 7 of ANCOLD (2012a).

10 Commissioning

Prior to full scale use of the TSF, a commissioning phase (Section 7.9, ANCOLD (2012a)) should be used to:

- confirm that all components of the TSF are functioning according to the specifications prior to tailings placement
- made safe and protect the works which may be damaged during the early placement of tailings (protection of drainage system)
- confirm the tailings properties/behaviour and dams/tailings facility behaviour against the design specifications.

PART D: OPERATION

11 Operation and maintenance manual

An operation and maintenance manual for use by operational personnel should be in place prior to the commissioning of a TSF.

The manual should document all relevant operational procedures for the specific site, and should reflect all items covered in the work plan and design that relate to operational, monitoring and surveillance procedures.

The level of detail in an operations manual should be determined by the characteristics of the specific site. However, the manual should document all relevant operational procedures, including:

- summary of risk review including key operational requirements resulting from the review
- background design information
- predicted behaviours of tailings
- roles and responsibilities of TSF personnel
- operating procedures for:
  - tailings discharge and deposition management
  - pipeline management
  - decant pond management
  - runoff pond management
  - water management and maintenance of freeboard
- maintenance schedule for:
  - tailings dam
  - decant system
  - runoff pond
  - pipelines
  - pumps
- inspection and monitoring schedule for:
  - tailings dam and associated structures
  - surrounding land and vegetation
  - pipelines
- dam safety auditing and monitoring including performance criteria
- record keeping
- reporting requirements
- incident or non-compliance reporting and tracking
- any additional requirements specified by the designer
- emergency response (see Section 13)
- requirements for periodic review and update of the manual.

Refer to *Guidelines on Dam Safety Management* (ANCOLD 2003), Appendix A and ANCOLD (2012a) Sections 8.1, 8.2 and 8.3 for additional details on the content of an operation and maintenance manual.

TSF personnel should have a detailed understanding of those aspects of the operations manual relevant to their day-to-day functions and responsibilities. All records related to operations and maintenance work should be kept onsite and made available for the periodic audit and review of TSF performance.

The operations and maintenance manual should be updated at least every two years to reflect operational experience, any significant changes in site conditions and to assess whether there are better ways of achieving the facilities' objectives.

11.1 Pipeline management

Records of inspection and maintenance of tailings pipelines and other tailings equipment should be maintained and made available for audit. The operation and maintenance manual should provide a brief description of the pipeline system including management of the decant system and key pipeline risk management issues.

12 Monitoring, auditing and reporting

12.1 Overview

Monitoring and auditing are essential management tools for the operation of a TSF and to confirm the operations are consistent with the design and operational expectations. A TSF is usually designed for particular tailings characteristics and expected embankment and foundation responses. Deviations from these particular characteristics could influence the operating procedures and the performance of the facility.

Where monitoring or audit indicates deficiencies in the risk assessment or risk reduction activities, there should be a clearly defined process for review of those measures.

The monitoring, auditing and reporting components of the program should be specified in the operations and maintenance manual.

Details and requirements for monitoring and surveillance are set out in ANCOLD (2012a) Section 8.4 and ANCOLD (2003a), Chapter 5. Proponents should meet these requirements in full.

12.2 Developing a monitoring program

Routine monitoring and inspections of a TSF are aimed at recording actual performance and identifying non-conformance with design or operational expectations so that timely maintenance or intervention can be implemented before any failure occurs. These inspections ensure that essential systems and procedures are maintained and improved where necessary. Inspections should be carried out by suitably experienced operations personnel and records of the inspections maintained.

The monitoring and inspections program should also make provision for non-routine inspections (and possible changes in monitoring frequency), following events such as major rainfalls resulting in excess water in the TSF, seismic events or where a deficiency has been identified.

A site-specific monitoring program should be developed to ensure early detection of any unexpected behaviour of the TSF and associated impacts. It should enable validation of the assumptions made in the design and risk assessment and indicate aspects of the operation where further risk analysis is warranted.

A program to monitor a TSF should:

- identify the scope of the program
- define the objectives of the program
- determine the indicators to be measured
- specify sample collection sites
- determine the monitoring frequency
- where appropriate, specify test methods and testing laboratory (NATA-accredited)
- nominate criteria for the review of performance and impacts related to stability, surface water land and groundwater
- use the Conceptual Site Model (CSM) developed for the site to help determine an appropriate monitoring plan and demonstrate compliance with relevant SEPPs
- include provision for assessment and reporting of results, particularly any that exceed specified limits
- document the required frequency of formal technical reviews of the structure
- for mining licensees, ensure that sites are able to fulfil the reporting requirements of Schedule 19 of the Mineral Resources (Sustainable Development) (Mineral Industries) Regulations 2013.

12.3 Trigger action response plan

The program should identify key monitoring parameters relating to both dam safety and environmental performance. As well as defining the acceptable upper levels of these items, a trigger response level should also be defined. Required actions and responses in the event of a trigger level being reached should be defined in the operations and maintenance manual. Each parameter requires the development of criteria in order to review its performance as part of the monitoring program. This performance criteria forms part of a Trigger Action Response Plan (TARP). Further details of what to include in a TARP are provided in Appendix III. Indicators and objectives outlined in relevant SEPPs can also be used to develop the trigger criteria.

12.4 TSF monitoring parameters – safety

Depending on the facility, parameters to be considered in a safety monitoring program for a TSF include:

- seepage or leakage through or around the embankment
- cracking, slips, movement or deformation of the embankment
- erosion of the embankment
- deposition management, beach development and size and location of water ponds on the tailings surface
- pond level and maintenance of the design minimum freeboard
- piezometric levels in embankments and foundations
- under-drain flow rates
- settlement and deformation of the embankment
- structural defects or obstruction in infrastructure
- characterisation and consolidation behaviour of the tailings, including beach development, drainage, density and desiccation
- monitoring of equipment and pipework
- seismic ground movement
- condition of diversion drains
- an evaluation of the operability and reliability of the installed instrumentation.

ANCOLD (2003a), Appendix B, provides further information on what to consider when determining what the monitoring program should include.

12.5 TSF monitoring parameters – environmental

A properly defined monitoring program will demonstrate that the TSF is achieving the design objectives in relation to dam safety and environmental performance. It will also help fulfil the reporting requirements of Item 12 of Schedule 19 of the Mineral Resources (Sustainable Development) (Mineral Industries) Regulations 2013 which refers to the 'environmental monitoring requirements' under the work plan for mining licences.

Environmental parameters that may require monitoring include:

- impacts on surface water and aquatic ecosystems
- impacts on soils and vegetation (waterlogging, salinisation)
- impacts on groundwater level and quality
- impacts on fauna
- levels of dust, noise vapour or odour.

Additional parameters to be monitored and the nature and detail of the monitoring will depend on issues identified in the site risk assessment. Relevant SEPPs should also be considered where determining the monitoring parameters.

12.6 Monitoring of transfers

In accordance with Item 12 of Schedule 19 of the MRSDMIR 2013, the volumes and chemical characteristics of tailings and process water transferred to or from a mining TSF must be monitored and included in the annual report as part of the normal reporting of the operation. Appendix II *Tailings Storage Facility Data Sheet*, provides a reporting pro-forma.

12.7 Auditing frequency and reporting

Monitoring of TSFs should be tailored to the size and nature of the TSF, its consequence category, and the associated risks identified in the risk assessment process. The proponent should implement a system of audit and review of the facility based on the frequency and type of audit as set out in Chapter 6 of ANCOLD (2003a). Tables 9 and 10 of ANCOLD (2012a) also provide a summary of these requirements.

In particular, an audit and review of dam safety and environmental performance should be undertaken at least annually (intermediate inspection) by a suitably qualified and experienced person such as a Dams Engineer, with specialist input as required. These audits will confirm that the operations are consistent with the work plan and this guideline and will also assess the adequacy of the monitoring program that is in place. The annual audit should also address the consolidation and achieved density of the tailings placed in the structure to review the timing of any subsequent proposed embankment lifts.

A typical table of contents for an annual inspection report is contained in ANCOLD (2012a), Appendix D.

The audit and inspection records provide an ongoing history of the facility, which is vital on sites where frequent personnel changes may occur, and assists with tailings management planning, wall lift scheduling and improvements to the overall operation.

For TSFs associated with mining sites, the annual audit report should be submitted to the department as part of the Schedule 19 reporting requirements outlined in MRSDMIR 2013.

The Tailings Storage Facility Data Sheet (Appendix II) may assist in fulfilling reporting requirements under Schedule 19.

12.8 Reviews

TSF performance reviews should be conducted at critical phases of the TSF lifecycle. Critical phases include commissioning, prior to embankment lifts and in conjunction with rehabilitation. The reviews should be treated separately from the annual reviews of the facility and should be carried out by an independent, suitably qualified and experienced party different to the designer or constructor.

13 Emergency response and incident reporting

13.1 Emergency response planning

A documented **emergency response plan** (ERP) should be prepared to address all specific issues relevant to the TSF and kept in a prominent and readily accessible location at the site. The scope and content of each ERP will depend on the size of the particular TSF and the identified consequences of failure.

The ERP should include responses to all potential emergency scenarios including, but not limited to, TSF failure, spill events and pipeline rupture. The ERP should include procedures describing and prioritising actions such as protection of personnel, the public, the environment and infrastructure, notification of emergency services and resource management agencies, advice to neighbours and immediate and longer term remedial actions. Implementation of such a plan could make a significant difference to the outcome of an incident.

Appendix V of this guideline and Section 8.5 of ANCOLD (2003a) provide more detailed information on the key aspects that should be included in an ERP. The emergency plan requirements for prescribed mines outlined in Regulation 5.3.34 of the *Occupational Health and Safety Regulations* 2007 also provides guidance that may also be useful for non-prescribed mines.

An emergency response plan should include, at a minimum:

- an assessment of persons, property, infrastructure and environmental features at risk
- a description of the physical or chemical characteristics of the tailings which may pose a risk to public safety, the environment or public infrastructure
- actions to be taken appropriate to the scale of the emergency, including lines of responsibility (and names and contact details of nominated safety personnel), communications, and involvement of police and emergency services
- details of any necessary evacuation procedure, including the location of assembly points, in the event of failure or impending failure
- accessible advice to all personnel on site as to the nature of the emergency warning system or warnings and procedures to be followed
- provision for training and refreshment programs of safety procedures for all personnel involved
- the types of equipment needed for initial response and later stages of clean up.

Proponents should also demonstrate that the provisions of the emergency response plan are based on a comprehensive risk assessment, including where relevant a dam-break analysis to confirm the extent of inundation and the population and environment at risk.

For TSFs with a high consequence of failure the co-ordination of site and external emergency response procedures should be trialled before commissioning of the TSF and periodically thereafter where major changes are made to the TSF structure or operational practices.

13.2 Emergency plan documentation

An ERP should be produced in an appropriate format separate from the main body of the work plan for the TSF. This will likely consist of a plan detailing the required information as well as procedures that provide an overview of what actions and notifications are required in the event of an emergency.

The approved ERP should be kept in a prominent and accessible location at the operation centre of the mining or extractive operation and should be available to all staff and emergency services for use in the case of an emergency. The licensee should forward a copy to the emergency services likely to attend the facility in the event of an incident.

The emergency plan should be part of the company's operating and maintenance plan and should be regularly reviewed by senior management. Corporate personnel responsible for emergency management should be clearly identified to all staff on the site, and on-site personnel receive adequate training for emergency procedures and incident reporting.

Further information on ERPs is provided in ANCOLD (2003a) *Guidelines on Dam Safety Management – Chapter 8*, and ANCOLD (2012a), Section 8.6.

13.3 Reporting of incidents and events

Requirements for reportable events are detailed in Regulation 33 of the MRSDMIR (2013).

Reportable events are events which occur at a site and result in, or have the potential to result in, significant impacts to public safety, the environment, public infrastructure or assets external to the site. They encompass actual or potential risks to the safe and stable conditions within, or external to, the site. Regulation 33(2) of the MRSDMIR 2013 provides the full definition of a 'reportable event'.

More detailed guidance on what is a reportable event and notification requirements is provided in the department's *Guidance Note on Reportable Events for Mineral and Extractive Operations.*

For sites with a TSF, events requiring notifications may include but are not limited to:

- uncontrolled release of tailings or supernatant water (broken pipe, overtopping of dam)
- seepage (discernible impact on vegetation, soil contamination, groundwater levels)
- defects in the structure of the TSF (cracking, slumping or significant erosion of the wall, faults in the decant system)
- exceeding the monitoring trigger levels related to surface water or groundwater quality
- injury or death of fauna on or near the TSF.

EPA notification is also required where there is a potential or actual impact on the community or the environment.

13.4 Management of emergencies

Where the TSF operator is unable to manage significant events within its own emergency management capability, the state emergency management arrangements may apply. These arrangements are detailed in the *Emergency Management Manual Victoria*.

This may include significant events such as tailings containment failure, particularly where there is risk to community members, critical infrastructure, residential properties, the environment and/or other community assets.

Refer to the *Emergency Management Manual Victoria* for more information on the state emergency management arrangements.

14 Decommissioning and closure

14.1 Overview

Tailings material should be securely stored for an indefinite period and present no hazard to public health and safety or the environment. Therefore the closure of a TSF and rehabilitation works should be as inherently stable, resistant to degradation and as consistent with the surrounding landscape as possible.

ANCOLD (2012a) sets sustainable closure as a target at the commencement of planning for a tailings dam. ANCOLD has adopted 1000 years as a notional post-closure life for the purpose of design and operational considerations, although longer periods are specified for specific design items including flood management and stability.

The closure of a TSF should be appropriate to the nature of the contents, relevant environmental considerations (land, water, air), the desired final landform and accord with community and landowner expectations. That is, the final landform design should be compatible with the form of containment or encapsulation of the tailings, the nature of the embankment materials, the needs of the community and the landowner, any legal requirements, climate, local topography and the level of management available after reclamation.

14.2 Closure plan

A closure plan developed in accordance with Section 9.2 – Closure Plan of ANCOLD (2012a), should be included in the initial work plan for the TSF. It should be regularly reviewed and updated as the project develops through design, construction, and operation. As outlined in ANCOLD (2012a), the closure plan should address:

- closure objectives and performance criteria
- required monitoring information, data collection, analysis and management
- site-specific issues (see Section 9.4 of ANCOLD 2012a)
- implementation of management and closure stages (active, passive and self-sustaining) and monitoring and auditing.

14.3 Long-term responsibility/land use

Management requirements for rehabilitated areas can continue beyond the life of the licence. The closure and rehabilitation of TSFs should be designed for the long term, with proponents providing for the long-term maintenance and upkeep costs associated with TSFs.

Where a TSF is located on Crown land, the department, in consultation with the Crown Land Manager, may seek to ensure that long-term responsibility is addressed by one or more of the following mechanisms:

- Suitable provision in a Crown Land compensation agreement;
- Establishment of an appropriate environmental levy; and/or
- Conclusion of a suitable closure agreement between the operator and the government.

The long-term use and maintenance of the land needs to be determined in consultation with the Crown Land Manager early in the approval process. At the end of operation, the department and the Crown Land Manager will ensure that rehabilitation of the TSF is sustainable prior to the bond being returned.

For private land, consultation with the owner of the land takes place before a rehabilitation plan is prepared by the proponent. The rehabilitation plan is incorporated into the work plan and becomes binding on the licensee when approved by the department. Rehabilitation requirements and long-term maintenance costs should be factored into a landholder's agreement, prepared between the landowner and the proponent.

At the end of the operation, the department will not return the bond for private land until rehabilitation works are complete and the owner of the land has been consulted.

14.4 Cover design

The proponent should demonstrate that the type and depth of cover proposed for closure of a TSF is suitable for the nature of the contained tailings, the proposed revegetation and subsequent management regime. The cover design should limit the amount of water ingress to the tailings.

Vegetation to be used should be compatible with the proposed cover design. This includes consideration of seepage and root zone movement which may enable water to get into the TSF, thus affecting the structural stability and potentially impacting on groundwater. Revegetation measures should be in accordance with the proposed final land use, and should make allowance for natural processes including erosion, wind action on vegetation, and fire.

The chemical and physical characteristics of the particular tailings and the topographic, hydrogeological, geotechnical and climatic characteristics of the disposal site usually determine the appropriate cover design.

Typical cover options for TSFs are described in Section 9.3 of ANCOLD (2012a).

14.5 Closure performance criteria

The closure design should include specific completion criteria. These should preferably be objective and quantifiable, and relate to environmental site management requirements. Completion criteria are the basis on which successful rehabilitation is determined, and needs to be developed in consultation with the land owner or land manager. This ensures that there is broad agreement on both the end land-use objectives and the basis for measuring the achievement of that objective (*Strategic Framework for Tailings Management*, 2003 (MCMPR & MCA)). The final completion criteria will need to be approved by the department and the land owner (the Crown Land Manager where the site is on Crown land) as part of the closure plan.

14.6 Post-closure monitoring and management

The proponent should design a monitoring program to demonstrate that completion criteria have been met and that the site is safe and stable. Broadly, and within the land-use objectives set for closure, monitoring of a decommissioned TSF should continue to demonstrate closure strategy performance until formal closure and resumption of management by the landowner.

A post-closure monitoring program should be designed to demonstrate that (MCMPR & MCA 2003):

- structures are geotechnically stable
- the closure water balance has been established and it demonstrates the expected performance including cover design and drainage
- covers are performing their intended role
- required plant growth has been successful and that a self-sustaining community has developed
- there is a low risk of an uncontrolled release of tailings or contaminants
- should an uncontrolled release occur, the release of contaminants or tailings will not result in recognisable detrimental effects on the water, soil and air surrounding the closed facility.

Post-closure monitoring should consider the relevant SEPPs and include:

- revegetation performance
- performance of flood mitigation and drainage control measures
- surface drainage and seepage
- erosion control
- groundwater level and quality
- embankment stability/deformation
- monitoring of equipment and pipework.

Unless full-scaled pre-closure trials have been carried out, it is unlikely that the success of the method of closure, and cover design for a TSF can be demonstrated in less than five years following cessation of operations. It may in fact take many more years than this to demonstrate successful closure. Proponents should make provision for the long-term costs associated with the upkeep and maintenance of the TSF during the closure period, and this should be included in the closure plan.

The closure plan may require a permanent program for periodic work for items such as surface water drainage line maintenance or vegetation control. This program should be included in the proposed closure plan with the nature of the work and associated costs. The work within the program and arrangements for program funding should be agreed with the land owner or land manager during the closure period.

A similar time frame may exist with respect to TSFs containing material with a potential to impact on groundwater. In such cases monitoring over several years may be required to demonstrate the actual impacts to groundwater level or quality.

15 Further information

For further information on matters discussed in this guideline or to discuss a proposal for a TSF, proponents should contact the Earth Resources Regulation Branch by emailing workplan.approvals@ecodev.vic.gov.au.

16 Appendices

APPENDIX I: DOCUMENTATION AND INFORMATION TO BE SUPPLIED TO THE DEPARTMENT FOR A TAILINGS STORAGE FACILITY

Documentation requirements referred to throughout this guideline are summarised in the table below.

Document	Description	When submitted
Risk assessment	A risk assessment is undertaken to support the siting, design, operation and monitoring of a TSF	Part of work plan
Design report	The report describes the site conditions, basis of the design, including the design concept/philosophy and all design parameters such as geotechnical properties of the tailings and construction materials, the meteorological conditions and the key performance criteria.	Part of work plan
Design certification	Certification from a responsible engineer that the design meets appropriate engineering and safety standards and is consistent with the guidelines.	Part of work plan
Environmental management plan	An environmental management plan describes how impacts on the surrounding environment will be controlled and monitored	Part of work plan
Community engagement plan	Describes how the licensee will engage with the community	Part of work plan
Closure plan	The closure plan outlines objectives, monitoring and auditing, specific environment related issues and implementation and management of closure stages	Part of work plan
Emergency response plan	Deals with emergency scenarios and includes procedures describing and prioritising such actions as protection of personnel, notification of emergency services and resource management agencies, advice to neighbours, and immediate actions.	Submit with work plan Update regularly
Incident and accident reporting	Reports about all accidents, incidents and emergencies affecting public and personnel health and safety, fauna, surface and groundwater, vegetation and infrastructure.	Part of work plan
Construction certification	Certification from a responsible engineer that the construction of the TSF accords with the certified and approved design plans	Following construction of TSF
'As constructed' reports	'As constructed' reports detailing the construction of each lift prepared and retained to assist determination of the overall stability and the future life of the TSF.	Following construction of TSF and revised following any subsequent lifts
Operations & maintenance manual;	Documents all relevant operational procedures for the systematic deposition of tailings, water and process chemicals in the facility.	Prior to operation of the TSF
Annual report: monitoring of transfers	Reports on the volumes and chemical characteristics of the tailings and process water transferred to or from a mining TSF. The reporting pro forma is provided in Appendix II Tailings Storage Facility Data Sheet.	Annually by 30th June
Annual audit reports	Reports the results of the annual audit to ensure that the TSF structure and essential systems are maintained and improved where necessary and that operational criteria are being met.	Annually by 30th June

APPENDIX II: TSF DATA SHEETS

The following proforma can be used for providing basic data about the proposed TSF for the initial work plan and for annual reporting.

TAILINGS STORAGE DATA SHEET

PROJECT DATA		
Licence/Work Authority:		Date:
Licensee:		
Operation / Site name:		TSF name:
Location:		Municipality:
TSF centre coordinates (AMG):	North	East
Name of data provider:		Phone:

TSF DATA					
TSF Status:	Proposed ☐	Operational☐	Care and maintenance ☐	Part rehabilitated ☐	Rehabilitated ☐

Type of TSF[1]:	Number of cells[2]:
Catchment area[3]:	Nearest watercourse:
Located on or off water course	Nearest sensitive receptors:
Date deposition started (mm/yy):	Date deposition completed:
Tailings discharge method[4]:	Water recovery method[5]:
Bottom of facility sealed or lined?: Y/N	Type of seal or liner[6]:
Depth to original groundwater level: m	Original groundwater TDS: mg/L
Ore process[7]:	Material storage rate[8]:

IMPOUNDMENT VOLUME:	Present;	m^3	Expected maximum;	m^3
MASS OF SOLIDS STORED:	Present;	tonnes	Expected maximum;	tonnes

Foundation soils:	Wall lifting by: Upstream ☐ Downstream ☐ Centre line ☐
Foundation rocks:	
Current wall lift number:	Planned number of wall lifts:

MAX WALL HEIGHT (AGL)[9]:	Present;	m	Expected;	m
CREST LENGTH:	Present;	m	Expected max;	m
WALL LENGTH:	Present;	m	Expected max;	m
SLOPE ANGLE OF EMBANKMENT				
IMPOUNDMENT AREA:	Present;	ha	Expected max;	m
AUDITS/INSPECTIONS	Date(s) undertaken:			

PROPERTIES OF TAILINGS		
TDS[10]: mg/l	pH:	Solids content%:
Deposited density t/m^3	WAD CN[11]: mg/l	Total CN: mg/l

CHEMICAL CONSTITUENTS OF TAILINGS[12]:

Constituent	Solid/Liquid	Conc. (units)[13]	Constituent	Solid/Liquid	Conc. (units)[11]

Explanatory notes for completing tailings storage data sheet

The following notes are provided to assist the proponent to complete the tailings storage data sheet.

1. Paddock (ring-dyke), cross-valley, side-hill, in-pit, depression, waste fill etc.
2. Number of cells operated using the same decant arrangement.
3. Internal for paddock (ring-dyke) type, internal plus external catchment for other facilities.
4. End of pipe (fixed), end of pipe (movable) single spigot, multi-spigots, cyclone, CTD (central thickened discharge) etc.
5. Gravity feed decant, pumped central decant, floating pump, wall/side mounted pump etc.
6. Clay, synthetic etc.
7. See list below for ore process method.
8. Tonnes of solids per year.
9. Maximum wall height above the ground level (AGL), not AHD or RL.
10. TDS means total dissolved solids.
11. WAD CN means weak acid dissociable cyanide.
12. All constituents occurring at concentrations of one per cent or greater of the tailings by mass should be reported. In addition, licensees should report those constituents occurring at lower concentrations but where the nature of the compound or its concentration results in potential for environmental or health impacts.

    The main components of the tailings can be assessed through assays of either the waste tailings material or of the original ore body itself and analysis of the liquid fraction. Licensees are asked to focus upon those components of the tailings with the most potential to impact upon the environment. Elements that may be significant include:

    - antimony
    - arsenic
    - barium
    - beryllium
    - boron
    - cadmium
    - chromium
    - cobalt
    - copper
    - iron
    - lead
    - manganese
    - mercury
    - molybdenum
    - nickel
    - selenium
    - silver
    - sulphur
    - thallium
    - tin
    - zinc

13. Specify the units of measurement for each compound.

    Operations producing sulphidic mine wastes should be assessed for the potential for sulphide oxidation resulting in acid generation. An outline of methods, including the net acid producing potential (NAPP) test and net acid generation (NAG) test, is provided *Preventing Acid and Metalliferous Drainage* (Australian Government 2016) and *EPA Publication 655.1 Acid Sulfate Soil and Rock* (EPA 2009).

Ore process methods

The ore process methods may be recorded as follows:

- Acid leaching (atmospheric)
- Alkali leaching (atmospheric)
- Bayer process
- BIOX
- CIL/CIP
- Flotation
- Heap leaching
- Ore sorters
- SX/EW (Solvent Extraction / Electrowinning)
- Acid leaching (pressure)
- Alkali leaching (pressure)
- Becher process
- Crushing and screening
- Washing and screening
- Gravity separation
- Magnetic separation
- Pyromet
- Vat leaching

APPENDIX III: TRIGGER ACTION RESPONSE PLAN

A Trigger Action Response Plan (TARP) is used to manage situations or activities that are critical to safe and stable mine operations. Each TARP is typically derived from a major hazard register which details each of the significant risks onsite requiring specific risk-management planning. A TARP should be developed for all the major hazards within a site.

The purpose of a TARP is to set out the expected or normal operational conditions for a particular aspect of the operation and define actions to be taken should outcomes differ from those that are expected. The focus of TARPS should be on risk prevention and control through early detection. A TARP provides a pre-prepared guideline on actions to be taken in critical situations. TARPs should be based on the best available advice from technically competent and experienced personnel.

TARPs should be demonstrably relevant to the specific site and hazard situation to which they are applied. The initial step in preparing a TARP is to define what constitutes ‘normal’ safe and stable operational conditions. Information can be gained from operational experience supported by monitoring or performance expectations based on design.

Events that differ from expected outcomes provide a ‘trigger’ for corrective actions. A TARP sets out response actions, responsibility for undertaking actions and a timeframe for action completion. Actions are typically graduated from the initial response should the risk escalate before controls become effective. For this reason TARPs typically contain several levels based on increased trigger levels that detail additional corrective actions should the initial response prove to be ineffective. To ensure a timely response can be taken at each trigger level preparatory work may be required to enable implementation of a TARP.

Trigger criteria should be readily identifiable. Monitoring programs should specify key monitoring parameters relating to safety, stability or environmental performance to be used as the basis for trigger levels. Each TARP and its triggers should be clearly linked to a hazard monitoring system and the recognition of a trigger point should be unambiguous. TARPs should allocate roles and responsibility for actions set out in the TARP. Nominated personnel should have suitable training and expertise for their roles. Adequate resources for actions defined in the TARP should be maintained onsite.

As mining hazards may change with time or location, trigger levels and corrective actions should be regularly reviewed to ensure they remain relevant to the hazard to be managed. If a TARP mandates an action, that action should be carried out promptly and completely. TARPs are a critical response to mining hazard risk prevention and control through early detection and corrective action.

A generic Trigger Action Response Plan layout is shown below.

	Trigger Action Response Plan		
TARP	Subject: (Major Risk Hazard)		
Level 1 Normal Event	Trigger	Action	Response
	Details of conditions normally expected. e.g. dam water level minimum 1 metre below spillway invert.	Actions under normal conditions. e.g. Daily observations by (responsible person).	Response to monitoring results. e.g. Water level at greater than 1m – continue current operation.
Level 2 Medium Risk Event	Trigger	Action	Response
	Details of conditions that require additional monitoring and action to return to normal conditions. e.g. Dam water level 0.75 to 1 metre below spillway invert.	Actions to return to normal conditions. e.g. Increase monitoring of dam and inflows / outflows (responsible person). Cease inflows or increase outflows (responsible person).	Expected monitoring results / outcomes of actions. e.g. Dam water level returned to 1m minimum within x time.
Level 3 High Risk Event	Trigger	Action	Response
	Details of conditions that require immediate action and may result in an emergency response. e.g. Dam water level less than 0.5m from spillway invert.	Actions to return to normal conditions. e.g. Increase monitoring of dam and inflows / outflows (responsible person). Cease inflows and increase outflows (responsible person). Enact Emergency Response Plan.	Expected monitoring results / outcomes of actions. e.g. Dam water level returned to 1m minimum within x time.

Document Owner	TARP Reviewer	Review Date

APPENDIX IV: EMERGENCY PLAN CONTENT FOR TAILINGS STORAGE FACILITIES

Development and review of an emergency response plan

Emergency plans should be established, tested and revised by the TSF operator:

- prior to commencement of operations
- if an accident or emergency situation occurred at the site or other similar sites
- after new technical knowledge becomes available or when new risks are identified
- if design values are approached as a result of changes, structural problems, equipment modification or natural events
- following significant organisational change
- at regular intervals as determined in the emergency plans themselves.

What is included in an emergency plan

The emergency plan should include:

- the scope and objective of the emergency plan
- evaluation of emergency scenarios, risks, potentially affected areas, etc.
- responsibilities of each member of the organisation (chain of responsibility and authority for actions to be taken)
- organisation of communication and notification procedures
- available equipment for interventions
- procedures for emergency response for each of the determined emergency scenarios
- procedures for remediation.

Specific emergency events and incidents

Among other things, the plan should evaluate downstream inundation hazards resulting from floods or dam failure, and upstream conditions that might result from major land displacements or increased flood flows. The emergency plans should include inundation maps for the flows resulting from design floods and from possible failure of the dam.

To evaluate the effects of dam failure, maps should be prepared delineating the area which would be inundated in the event of failure. Analyses should be made to determine conditions which could be expected to result in slow, rapid or practically instantaneous dam failure.

Emergency plans should be developed for each specific site and situation. This may include emergency events such as:

- high rainfall
- storm
- earthquake

Other emergency incidents to be considered in the emergency response plan include:

- embankment overtopping
- wave damage, cracking, slips
- structural failure slides
- increased or new seepage, pipeline leakage
- other abnormal signs or behaviours.

Prior to development of an emergency plan an analysis should be made to determine the most likely mode of dam failure under the most adverse conditions and the resulting peak water outflow following the failure. The analysis should also identify any chemical substances or other potentially polluting materials that might be released in event of a TSF failure.

Emergency plans should contain estimations of availability and types of equipment needed to deal with polluting or dangerous releases as well as construction materials and equipment needed for emergency repairs of the TSF based on the structural, foundation and other characteristics of the dams. Provisions should also be made for clean-up of any material that might be released from a TSF.

Notification Procedures

Plans for notification of key personnel, local authorities, emergency services and the public are an integral part of the emergency plan and should be prepared for all types of dam failure conditions. Phone numbers and key contact names should be clearly displayed as part of the plan. Contacts should include:

- Victoria Police
- State Emergency Service
- WorkSafe Victoria
- Dam's Engineer/Designer
- Earth Resources Regulation
- EPA
- local council
- owners of nearby public infrastructure – eg VicRoads
- downstream neighbours
- water corporations

Contact information should be updated as required.

Emergency information should be pre-prepared for circulation to stakeholders covering the tailings storage facility and its use, type of tailings and contents, possible inundation areas and potential risks to human health and the environment. The information may also need to cover post-emergency recovery activities and the management of ongoing risks.

APPENDIX V: RELEVANT LEGISLATION AND POLICIES

Mineral Resources (Sustainable Development) Act 1990

The purpose of this Act is to encourage exploration and economically viable mining and extractive industries which make the best use of, and extract the value from, resources in a way that is compatible with the economic, environmental, and social objectives of the state. Its objectives include encouraging and facilitating exploration for minerals and establishing a legal framework to ensure that mineral resources are developed in ways that minimise impacts on the environment. The framework also promotes effective consultation mechanisms and the need for appropriate access to information for land that is being mined and/or rehabilitated. The Act also provides for conditions on licences and approvals as well as enforcement.

Occupational Health and Safety Act 2004

The objectives of this Act include: securing the health, safety and welfare of employees and other persons at work; eliminating, at the source, risks to the health, safety or welfare of employees and other persons at work; ensuring that the health and safety of members of the public is not placed at risk by the conduct or undertakings by employers and self-employed persons; and providing for the involvement of employees, employers, and organisations representing those persons, in the formulation and implementation of health, safety and welfare standards.

The Occupational Health and Safety Regulations 2007 – Part 5.3 Mines, provides specific requirements regarding health and safety in mines. Additional duties are also required for prescribed mines.

Environment Effects Act 1978

This Act provides for the administering Minister to decide whether any proposed development requires an Environment Effects Statement (EES). Where an EES is required for a mining project, approval procedures are coordinated as closely as possible and the proponent is not required to obtain further planning approvals for the activity assessed in the EES.

Planning and Environment Act 1987

This Act provides a framework for planning the use, development and protection of land in Victoria. It has a number of aims related to environmental protection, social equity and facilitation of appropriate development.

The Act provides the overarching process for responsible authorities (RA) to consider and approve, or refuse to approve, applications by mining and extractive industries. In most instances the RA is the relevant municipality. The RA utilises the approved local municipality planning scheme, including the State Planning Policy Framework, in support of its considerations. Approval takes the form of a planning permit.

Permitted Clearing of Native Vegetation – Biodiversity Assessment Guidelines

Any proposals for the clearing of vegetation will be assessed by Department of Environment, Land, Water and Planning in accordance with the *Permitted clearing of native vegetation – biodiversity assessment guidelines* through the work plan process.

Proponents must take all reasonable measures to avoid and minimise and /or offset the removal and disturbance of native vegetation.

Environment Protection Act 1970

This Act is concerned with all aspects of the environment and makes provision for the establishment of environmental objectives as well as management of waste discharges.

The EP Act aims to:

- encourage waste avoidance, reduction and re-use
- control emissions of waste into the atmosphere and on land and water
- penalise polluters.

This Act provides for the preparation of SEPPs which set quality objectives for segments of the environment such as air, water and land and noise emissions. The provisions of SEPPs apply to government departments, agencies and private companies. They provide a basis for the application of works approvals, licences, pollution abatement notices and regulations.

Policies that relevant to these guidelines are:

- *SEPP (Waters of Victoria) 2003* – determines the beneficial uses of the water environment to be protected, water quality indicators and objectives for specific segments of the water environment
- *SEPP (Groundwaters of Victoria) 1997* – aims to maintain and, where necessary, improve groundwater quality sufficient to protect existing and potential beneficial uses
- *SEPP (Air Quality Management) 2001*
- *SEPP (Prevention and Management of Contaminated Land) 2002*
- *SEPP (Control of Noise from Commerce, Industry and Trade) No. N-1, 2001* – applies to the Melbourne metropolitan region
- EPA Publication 1411, *Noise from industry in regional Victoria, 2011* – applies to areas of Victoria outside of metropolitan Melbourne.

The Environment Protection (Scheduled Premises and Exemptions) Regulations 2007

These regulations prescribe the premises that are subject to works approval and/or licensing by EPA, and provide for exemptions in certain circumstances.

Under these regulations, disposal of wastewater to land within a mine or quarry site in accordance with an approval under the MRSDA does not require a works approval or licence. This situation applies where water is discharged to a TSF, an evaporation pond or to some other system that ensures no off-site discharge occurs.

If a proposal includes an off-site discharge of water to the environment a works approval and licence will be required under the EP Act.

Catchment and Land Protection Act 1994

This Act aims to:

- set up a framework for integrated management and protection of catchments
- encourage community participation in the management of land and water resources
- set up a system of controls on noxious weeds and pest animals.

Catchment Management Authorities (CMA) established under the Act are responsible for the development and coordination of approved regional catchment management strategies. These strategies may address issues such as salinity, pest plants and animals, nutrient inflows to streams and declining biodiversity.

Water Act 1989

This Act applies to all surface and groundwater in Victoria, river management, water supply, irrigation and sewerage.

Section 67 of the *Water Act 1989* sets out the circumstances in which a licence for the construction, alteration, operation, removal or decommissioning of a private dam may be required. Licensing is required where a dam is (or is proposed to be):

- on a waterway or
- off a waterway and it:
  (a) has a wall that is 5 metres or more high above ground level at the downstream end of the dam and a capacity of 50 megalitres or more or
  (b) has a wall that is 10 metres or more high above ground level at the downstream end of the dam and a capacity of 20 megalitres or more or
  (c) has a wall that is 15 metres or more high above ground level at the downstream end of the dam, regardless of the capacity or
  (d) is a dam belonging to a prescribed class of dams.

Licensing powers and functions have been delegated to the Rural Water Corporations (RWCs).

Flora and Fauna Guarantee Act 1988

This Act establishes a legal and administrative structure to enable and promote the conservation of Victoria's native flora and fauna and to manage potentially threatening processes. It provides a list of species and communities of flora and fauna that are threatened and mechanisms for their protection. A permit is required to undertake works on public land which might kill, injure or disturb protected native plants and/or animals. In most cases, a licence or permit is not required for works on private land.

Forest Act 1958

This Act provides for the management and protection of state forests, defines the powers of the secretary and the power to issue leases and licences, places restrictions on the cutting or removing of timber or forest produce, and makes provision for other forest-related matters.

Crown Land (Reserves) Act 1978

This Act provides for the reservation of Crown lands for certain purposes and for the management of such reserved lands. Many reserved lands are restricted Crown land for the purposes of the MRSDA.

Aboriginal Heritage Act 2006

This Act protects places and objects of Aboriginal cultural heritage significance in Victoria. A feature of this Act is the requirement for a Cultural Heritage Management Plans (CHMPs) when a proponent proposes to carry out listed high-impact activities (listed under the *Aboriginal Heritage Regulations 2007*) in areas of cultural heritage sensitivity.

It is an offence under the AH Act to knowingly, recklessly or negligently undertake an action that harms or is likely to harm an Aboriginal place or object without a cultural heritage permit or an approved cultural heritage management plan in place.

If items of Aboriginal cultural heritage value are found during construction activities and no CHMP was required, it should be reported to the Office of Aboriginal Affairs Victoria. The proponent would then need to obtain a permit to continue to work or disturb the Aboriginal cultural heritage sites.

Environment Protection and Biodiversity Conservation Act 1999

This Act provides for the protection of the environment (including biodiversity and cultural heritage values), especially those aspects of the environment that are matters of national environmental significance.

Under the Act, Commonwealth approval is required for actions that are likely to have a significant impact on:

- a matter of national environmental significance
- the environment of Commonwealth land (even if taken outside Commonwealth land)
- the environment anywhere in the world (if the action is undertaken by the Commonwealth).

The Act provides for the listing of nationally threatened native species and ecological communities, and also the listing of nationally significant cultural heritage sites.

APPENDIX VI: DEFINITIONS

Annual Exceedance Probability (AEP) – the probability that a particular storm or event will be exceeded in any year e.g. one in 1000 AEP Storm – a storm event which produces a rainfall that is statistically likely to occur once in a 1000 years at the site under study.

Earth Resources Regulation – Earth Resources Regulation (ERR) regulates the mineral, extractive, petroleum, pipeline, greenhouse gas storage and geothermal industries in Victoria and the environment in its offshore coastal waters. ERR regulates the mineral and extractive industries through the administration of the *Mineral Resources (Sustainable Development) Act 1990* (MRSDA) and subordinate legislation. ERR's regulatory role is principally the assessment of applications, issuing of licences, approval of works and other compliance activities. ERR also prepares a range of guidance documents to assist industry in meeting their obligations under the MRSDA.

Consequence category – There are two consequence categories that need to be assessed as part of the Tailings Dam Design, the Dam Failure Consequence Category and the Environmental Spill Consequence Category. These are used to determine various design and operational requirements including design of spillways and for flood storage requirements.

Dams Engineer – An engineer experienced in investigation, planning, design, construction or management of dams and qualified to undertake work in the field of dams. Some aspects of tailings engineering may require specialist input. A specialist would be a person with special skills such as geochemistry, hydrogeology etc.

Design certification – confirmation from a suitably qualified designer that the design meets appropriate engineering and safety standards and is consistent with this guideline.

Department – the Victorian State Department for the time responsible for the administration of the *Mineral Resources (Sustainable Development) Act 1990*.

Freeboard – the vertical distance between the operating or predicted water level in a storage and the crest level where water would flow over the dam.

Hazard – a source of potential harm or a situation with potential for harm and its potential consequences.

Large TSFs – are those:

- with an embankment of 5 metres or higher and a storage capacity of 50 megalitres (50,000 cubic metres) or more;
- with an embankment of 10 metres or higher and a storage capacity of 20 megalitres (20,000 cubic metres) or more;
- with an embankment of 15 metres or higher, regardless of storage capacity; or
- where the combined storage capacity of all TSFs on the site is 50 megalitres (50,000 cubic metres) or more; or
- Where the tailings contain or are predicted to contain, concentrations of contaminants exceeding those levels specified in Section 6.4 of this document regardless of capacity or size.

Licensing authority – a water corporation that has the power to issue a licence to construct works as delegated by the Victorian Minister for Water.

Likelihood – a qualitative term encompassing both probability and frequency.

Piezometric level – the level that groundwater rises to in a piezometer. This is a measure of groundwater pressure.

Pore water – water in the spaces between particles (of sand, rock, tailings materials, etc).

Private dam – anything in which by means of an excavation, a bank, a barrier or other works water is collected, stored or concentrated but does not include:

- anything owned or operated by a public statutory body
- any works of an Authority
- a channel, drain or pipe
- a bore.

Responsible Authority – is the municipal council, where the planning scheme applies to land which is wholly or partly in its municipal district, unless the planning scheme specifies any other person as the responsible authority.

Rheological – flow characteristics of liquids with suspended particles.

Risk – the likelihood of particular event or set of circumstances being realised as compounded by its consequences.

Risk Analysis – the systematic use of available information to identify hazards and to estimate, quantitatively or qualitatively, the likelihood and consequences of those hazards being realised (how often a specific event may occur and its magnitude).

Risk Assessment – the evaluation of the results of risk analysis against predetermined standards, target risk levels or other criteria. This helps to determine acceptability or tolerability of the levels of risk remaining after control measures have been implemented. It is also used to determine risk management priorities (or the effectiveness or cost-effectiveness of alternative risk management options and strategies).

Risk Management – the systematic application of policies, procedures and practices to the task of identifying hazards; analysing the consequences and likelihoods associated with those hazards; estimating risk levels (quantitatively or qualitatively); assessing those levels of risk against relevant criteria and targets; making decisions and acting to reduce risk levels. Actions involve consideration of legal, economic and behavioural factors.

Slime – silt- or clay-sized material; usually with high water content.

Small TSFs – are those which are not classified as a large TSF (see definition of ‘large TSF’ above).

Stochastic Water Balance – variable water balance.

Supernatant water – free water that has collected on the surface of deposited tailings or slurry.

Tailings – comprise the residue or waste that comes out of the ‘tail’ end of a processing plant. In the context of mining, these processes generally produce fine-grained products as a result of ore crushing, pre-existing grain sizes or chemical precipitation. The processes themselves are generally water based and the tailings are, for the most part, produced as a slurry of solid particles suspended in water.

Tailings Dam – a structure or embankment that is built to retain tailings and/or to manage water associated with the storage of tailings, and includes the content of the structure. This does not include separate water dams (e.g. seepage collection dams or clarification ponds) that may be part of the overall tailings management system.

Tailings Storage Facility (TSF) – an area used to confine tailings and includes containment embankments and associated infrastructure.

Waterway is defined in the *Water Act 1989* as:

(a) a river, creek, stream or watercourse; or
(b) a natural channel in which water regularly flows, whether or not the flow is continuous; or
(c) a channel formed wholly or partly by the alteration or relocation of a waterway as described in paragraph (a) or (b); or
(d) a lake, lagoon, swamp or marsh (described in more detail in the Water Act 1989)
(e) land on which, as a result of works constructed on a waterway as described in (a), (b) or (c), water collects regularly, whether or not the collection is continuous; or
(f) land which is regularly covered by water from a waterway as described in paragraph (a), (b), (c), (d) or (e) but does not include any artificial channel or work which diverts water away from such a waterway; or
(g) if any land described in paragraph (f) forms part of a slope rising from the waterway to a definite lip, the land up to that lip.

APPENDIX VII: REFERENCES

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